FRENCH REPUBLIC

NATIONAL INSTITUTE
OF INTELLECTUAL PROPERTY

PARIS
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(11) Publication No.: **2 462 787**
(For reprint orders only)

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PATENT APPLICATION

(21) **No. 79 19430**

(54) **Transition device between an ultra-high frequency line and a waveguide and ultra-high frequency source comprising such transition**

(51) International Classification (Int. Cl.^{3}). **H 01 P 5/08**

(22) Application Date .... **July 27, 1979**

(33)(32)(33) Priority claimed:

(41) Date patent application layed open to public inspection .... **B.O.P.I. – «Lists» No. 7 of 2/13/81**

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The invention relates to a transition device between a waveguide and ultra-high frequency line and also an ultra-high frequency source comprising such a transition.

Ultra-high frequency oscillators manufactured from discrete components assembled on a printed circuit are very often used in ultra-high frequency devices. In such case, for example, these oscillators utilize microstrip-, triplate- or coplanar-type ultra-high frequency lines as the resonant circuit.

These oscillators being very often used to energize devices utilizing waveguides, the problem of minimum transition loss and standing ratios arises.

In the prior art one generally uses coaxial line elements whose central driver is inserted into the waveguide whereas the conducting sheath is connected to the conducting walls of this waveguide.

This type of transition presents several disadvantages:

Because the ultra-high frequency oscillator is usually manufactured using printed circuit technology, an additional microstrip line-coaxial line transition is necessary.

On the one hand, this additional transition increases insertion losses and on the other this type of transition occurs under considerable volume. Lastly, manufacturing cost is relatively high.

The present invention proposes to correct these disadvantages.

According to one characteristic of the invention the transition device between a waveguide and ultra-high frequency line comprises, connected to the ultra-high frequency line, two conducting parallel plates attached to the end of a waveguide and forming an angle α to the axis of symmetry of this waveguide, one of these conducting plates having a surface covering at least the sectional surface of the waveguide; the other, included between this first conducting plate and the section of the waveguide, a surface whose maximum size is limited to the sectional surface of the waveguide.

Other advantages and characteristics of this invention will result from the description which follows with the aid of the figures which represent:

- figures 1a and 1b, two variants of a transition device between a coaxial line and waveguide of the prior art;

- figures 2a and 2b, an exemplified embodiment of a radiating element assembled on a dielectric plate and the distribution of resulting electric fields;

- figures 3a, 3b, 3c and 3d, four possible configuration variants of this radiating element of figure 2a;

- figure 4, a first exemplified embodiment of a configuration of an ultra-high frequency line-waveguide transition device according to the invention;

- figure 5, a second exemplified embodiment of a configuration of an ultra-high frequency line-waveguide transition device according to the invention;

- figures 6a and 6b, a third exemplified embodiment of a configuration of an ultra-high frequency line-waveguide transition device according to the invention seen in perspective and in longitudinal section.

Figure 1a shows a first exemplified embodiment of a coaxial line-waveguide transition of the prior art.

It comprises a coaxial line consisting of two drivers 1 and 2 with axial symmetry, and a waveguide 3. The central driver 1 of the coaxial line penetrates into the waveguide 3 thus forming an exciter probe 4; this type of transition is therefore transversal. One particular disadvantage of this type of transition derives from the mounting of the coaxial line on the waveguide 3 whose rigidity must be sufficient to maintain the exciter probe 4 in a fixed direction.

Figure 1b shows a second exemplified embodiment of a coaxial line-waveguide transition of the prior art.

It comprises the same components as those of figure 1a, but arrayed differently.

In this exemplified embodiment the coaxial line is connected longitudinally to the waveguide 3; moreover, in such case the exciter probe 4 preferably has the shape of a plate whose width increases as it approaches one of the walls of the waveguide to which it is electrically connected. One disadvantage of this coaxial line-waveguide transition type originates from the exciter probe whose geometry makes its manufacture delicate and therefore expensive.

The present invention proposes correcting these disadvantages by using radiating elements, an example of which is shown in figures 2a and 2b.

The radiating element of figure 2a comprises a plate made of dielectric material 7, one of whose sides is completely covered by a conducting plate and whose other side has a conducting surface 5 electrically connected to a conducting strip 6 forming a microstrip-type ultra-high frequency line with the conducting plate 8.

Figures 3a, 3b, 3c and 3d show nonrestrictive embodiments of energization of a radiating element 5.

Figure 3a repeats the embodiment of figure 2a with a difference in shape for the radiating element 5 which, in figure 3a, is disk-shaped.

Figure 3b shows a rectangularly shaped radiating element 5; however, this figure illustrates above all the possibility of energizing this radiating element 5 via a coplanar line comprised of a conducting strip 6 and the conducting plate 9 surrounding the radiating element 5 unit while however remaining electrically insulated from it. In that case the conducting plate 8 acts as a reflector for the ultra-high frequency waves.

Figure 3c shows a radiating element attached to a first side of the plate made of dielectric material 7 and energized by a coplanar line comprised of a conducting strip 6 and the conducting plate 8 attached to the second side of the substrate made of dielectric material. The radiating element 5 and the conducting strip 6 are then connected by an electric connection such that the contact point of this connection on the radiating element 5 is distinct from the center of symmetry of this radiating element 5 if it exists.

Figure 3d shows an array very similar to that of figure 3c but directly energized via a coaxial line whose center conductor 6 is electrically connected at a point 10 of the radiating element 5 and the external conductor 11 of this coaxial line to the conducting plate 8, the conducting plate 8 and radiating element 5 each being on one side of the substrate made of dielectric material 7.

The present invention proposes combining these radiating elements with a waveguide. The interacting of these two means allows the transmission of an ultra-high frequency signal from the ultra-high frequency waveguide line and conversely.

The excitation modes of these disk-shaped radiating elements 5 are known. The electric field E radiated by such a disk has a direction parallel to the right, passing through the center of the conducting plate and the point 10 of application of the energizing ultra-high frequency signal.

Figures 4, 5, 6a and 6b show three nonrestrictive embodiments of ultra-high frequency line-waveguide transition devices according to the invention.

Figure 4 shows an ultra-high frequency-waveguide transition device comprising a waveguide 3 to which a radiating element 5 energized by a coplanar line whose structure was already described for figure 3b. The waveguide 3 is mounted in such a manner that the walls of this waveguide 3 are in electrical contact with the conducting plate 9 surrounding the radiating element 5 connected to the conducting strip 6. The second conducting side 8 of the substrate made of dielectric material 7 can comprise electrical connections to the metal walls of the waveguide 3. A notch is cut into the waveguide 3 in order to prevent electrical contact between it and the conducting strip 6.

According to a preferred but nonrestrictive specific embodiment, the plate of the substrate made of dielectric material 7 supporting the radiating element 5 is attached according to a right section of the waveguide 3. *//translator's note: The preceding sentence does not make sense in French. The French word "selon" means "according to" or similar variants of that term.//* It is however possible to attach the substrate made of dielectric material 7 such that it forms an angle α to the axis of symmetry of this waveguide 3. In the continuation of the description it will be assumed that $\alpha = 90°$.

According to a preferred but nonrestrictive specific embodiment the radiating element 5 is attached to the center of the waveguide 3. It is however possible to mount it in other positions and this will be the case particularly if several radiating conducting surfaces are arrayed on the surface of the dielectric material 7 turned toward the inside of the waveguide 3.

These radiating elements 5 can be of any shape although a simple solution consists in selecting them in the shape of disks. These radiating elements are energized either by a conducting strip 6 forming part of a microstrip or coplanar line or by a coaxial line. In the case of energization via coaxial line, each radiating element 5 will be connected to this coaxial line at a point 10 different from the center of symmetry of this radiating element 5; the position of this point 10 depending on the mode one wishes to excite in the waveguide 3. To excite mode TE_{01} in the waveguide 3 it necessary to excite the radiating element 5 following its first resonance frequency; this mode being even, the waveguide 3 is easily excitable.

Figure 5 shows a second embodiment of an ultra-high frequency-waveguide transition device according to the invention. This figure shows a disk-shaped radiating element 5 energized by a microstrip line; as was already stated, a form other than that of a disk can be selected for this radiating element 5, for example a square, a triangle, an ellipse. The conducting strip 6 forming with the conducting plate 8 the microstrip energization line is such that if excitation of the waveguide 3 in the TE_{01} mode is desired, its direction is parallel to the small sides of the section of the waveguide 3.

To excite other modes, the position of the radiating element can differ from the center of the section of the waveguide 3, the conducting strip 6 can have a different direction and, finally, several radiating elements 5 can be used.

Figures 6a and 6b show an energization variant of the ultra-high frequency line-waveguide transition device described in figure 5. In this figure 6a, the latter in actuality consists of a coaxial line whose external conductor is electrically connected to the conducting plate 8 and whose internal conductor 6 is electrically connected to the radiating element 5 at a point 10 different from the center of symmetry of this radiating element.

In certain cases the plate made of dielectric material 7 will be able to comprise several radiating elements 5, each one of which being energized by a different ultra-high frequency line of any type. In such case one obtains, inside the waveguide 3, a combination of different signals applied to different ultra-high frequency lines.

Any shape of the waveguide 3 can be selected.

The plate made of dielectric material 7 can consist of any material and in particular can simply be a layer of gas such as, for example, air. In this case the conducting surfaces 5, 8 are selected sufficiently thick in order to have good rigidity.

This plate made of dielectric material 7 can also be used as a printed circuit on which to assemble, for example, the different components which make up the ultra-high frequency source which is thereby connected to the transition device, which limits dissipation of energy.

Thus, a transition device between at least one ultra-high frequency line and a waveguide and a ultra-high frequency source comprising such transition has been described.

CLAIMS

1. Transition device between a waveguide and ultra-high frequency line characterized in that it consists of, connected to the ultra-high frequency line (6), two parallel conducting plates (5 and 8) attached to the end of a waveguide (3) and forming an angle α to the axis of symmetry of this waveguide (3), one of these conducting plates having a surface covering at least the sectional surface of the waveguide (3); the other, included between this first conducting plate and the section of the waveguide and acting as a radiating element, a surface whose maximum size is limited to the sectional surface of the waveguide (3).
2. Transition device according to claim 1, characterized in that this angle α is equal to 90°.
3. Transition device according to claim 1, characterized in that the interval between the two conducting plates (5 and 8) is less than the wavelength of the ultra-high frequency signal applied to this transition.
4. Transition device according to claim 1, characterized in that the ultra-high frequency signal is applied to the ultra-high frequency line (6).
5. Transition device according to claim 1, characterized in that the two conducting plates (5 and 8) are attached to both sides of a plate made of dielectric material (7).
6. Transition device according to claim 1, characterized in that the conducting plate (5) acting as a radiating element comprises at least two pieces (5 and 9) dielectrically insulated from each other, one of them at least being connected to the ultra-high frequency line.
7. Transition device according to claim 1, characterized in that the conducting plate (5) receiving the radiating element consists solely of conducting disks connected in parallel to a conductor of the ultra-high frequency line.
8. Transition device according to claims 1 and 5, characterized in that the two conducting plates (5 and 8) are connected to microstrip or coplanar lines supported by the plate made of dielectric material (7).
9. Transition device according to claim 1, characterized in that the ultra-high frequency line is of the coaxial type.
10. Transition device according to claim 5, characterized in that the plate made of dielectric material (7) also serves as support for a printed circuit on which are assembled the components which make up the ultra-high frequency source.
11. Transition device according to claim 1, characterized in that the conducting plate (5) acting as a radiating element consists of a single conducting plate whose surface is less than the sectional surface of the waveguide (8) and whose shape is a square, a rectangle, a disk or a triangle.
12. Ultra-high frequency source assembled on a printed circuit, characterized in that it consists of a transition device according to any of the preceding claims.